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ATTENTION IN ATYPICAL AND AVERAGE LEARNERS

SELECTIVE AND SUSTAINED ATTENTION IN ATTENTION DISORDERED, LEARNING DISABLED, AND AVERAGE LEARNERS

Richard Conte, Harry Zirk, and Marilyn Samuels

The Learning Centre

Calgary, Alberta

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ABSTRACT

Review of the literature suggests the presence of both sustained and selective attention deficits in attention deficit disordered (ADD) children. In the present work sustained attention was defined in terms of tasks in which there is a learning or memory component, and in which the experimenter has control over the amount of processing time available. Selective attention tasks are those in which subjects must make comparisons or act on perceptual attributes, and in which the subject has control over the time avaiable to process the relevant information. Previous work has suggested that ADD children, but not normal controls, show deficits on both types of attention tasks. An essential control lacking in these studies is a group of learning disabled children who do not fit the criteria for an attention deficit disorder. Without this control group one cannot be entirely confident that the two types of attention deficits are unique to ADD children.

In the present study performance was contrasted on a selective attention task (The Matching Familiar Figures Test) and a sustained attention task (paired associate learning). The Matching Familiar Figures Test (MFFT) is a match-to-sample task in which subjects must determine which of 6 response alternatives matches exactly the standard stimulus figure. This task was used on the assumption that children with short attention span would respond before they could adequately process all the relevant information. This approach to the task would result in high error rates and short response times. In the paired associate learning (PAL) test, performance was compared across two presentation

rate conditions on the assumption that children with short attention span would learn more efficiently when relatively fast rates of presentation were used. This expectation was based on the notion that relatively long trails (12 seconds) in the slow presentation rate condition would exceed the limited attention span of ADD children, whereas the shorter trials in the faster presentation rate condition (6 second) would not exceed their attention span.

Experiment 1 contrasted the performance of ADD, LD and normal controls on the sustained and selective attention tasks described above. ADD children were defined in terms of the hyperkinesis index of the Conners Teacher Rating Scale. The results indicated that there were deficits in sustained attention for the LD and ADD groups (i.e, both learned significantly less at the slow rate than the fast rate), but a selective attention deficit in the LD group only. There was no indication of either type of attention deficit in the normal controls. These findings suggested that there may be attention deficits in learning disordered children who do not satisfy the criteria for ADD as defined by the Conners Questionnaire.

The tasks used in Experiment 1 required subjects to process visual-spatial information, and it is conceivable that between group differences in aptitude to process such information (rather than an attention deficit) may have affected performance. To investigate this issue, Experiment 2 examined the relationship between performance on the sustained and selective attention tasks, and performance on two measures of visual-spatial ability. The results indicated that the LD

and ADD groups had significantly lower scores on both visual-spatial tasks than the normal controls, suggesting that visual-spatial ability may have led to the between group differences in attention obtained in Experiment 1. Further analysis indicated that performance on the visual-spatial tasks was significantly related to performance on the selective attention task, but not the sustained attention task. However, it was concluded that this may have occurred because of the general similarity between the requirements of the selective attention task and the measures of visual-spatial skill, Suggestions were offered for how it may be possible to disentangle the relative contributions of visual-spatial skill from attention.

In Experiment 3 an attempt was made to shorten the amount of time required to present the sustained attention task used in Experiment 1. This was accomplished by utilizing amixed list in which half the items in a list of paired associates were presented at the 12 second rate of presentation and half at the 6 second rate. If children with short attention span learn less efficiently at the 12 second rate because the length of these trials exceeds their short attention span, then this effect should occur in the mixed list condition just as strongly as it did in Experiment 1. However, the results of Experiment 3 indicated that no presentation rate effects were obtained when both rates of presentation were used in the same list. This suggested that a necessary condition required to obtain the difference in performance across rates of presentation at the slow rate. Thus, the present findings indicate that it is not possible to obtain presentation rate effects when both rates are presented within a single list.

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TABLE OF CONTENTS

ABSTRACT.....i

ACKNOWLEDGEMENTS.....iv

TABLE OF CONTENTS.....v

LIST OF TABLES AND FIGURES.....vii

LIST OF APPENDICES.....viii

I. INTRODUCTION.....1

A. Literature Review of Assessment Methods.....3
1. Behaviour Rating Scales.....3
2. Cognitive Tests.....5
a. Selective Attention Tasks.....6
b. Sustained Attention Tasks.....8

B. Summary
1. Evaluation of Methods of Assessing Attention Disorders.....11
2. The Role of Visual-Spatial Ability in the Measurement of Attention Disorders.13

II. PURPOSE.....14

III. EXPERIMENT 1: A COMPARISON OF SELECTIVE AND SUSTAINED ATTENTION IN ATTENTION-DISORDERED LEARNING-DISORDERED AND NORMAL CHILDREN.....16

A. Purpose.....16

B. Experimental Questions.....16

C. Methodology.....17

D. Results.....23

E. Discussion.....28

TABLE OF CONTENTS (continued)

IV. EXPERIMENT 2: THE ROLE OF VISUAL-SPATIAL ABILITY IN THE MEASUREMENT OF SUSTAINED AND SELECTIVE ATTENTION DEFICIT.....31

A. Purpose.....31

B. Experimental Questions.....31

C. Methodology.....32

D. Results.....33

E. Discussion.....35

V. EXPERIMENT 3: PRESENTATION RATE EFFECTS DURING A MIXED LIST CONDITION.....38

A. Purpose.....38

B. Experimental Questions.....38

C. Methodology.....39

D. Results.....39

E. Discussion.....40

VI. GENERAL DISCUSSION.....42

A. Selective and Sustained Attention in ADD and LD Children.....42

B. The Role of Visual-Spatial Ability in the Measurement of Attention Disorders.....44

C. The Mechanism of the Presentation Rate Effect...46

D. Remedial Implications of the Data.....47

E. Conclusions and Recommendations.....48

VII. REFERENCES.....52

VIII. APPENDICES.....56

TABLES AND FIGURES

TABLE 1: WISC-R SCORES.....23a

TABLE 2: CONNERS TEACHER RATING SCALE DATA.....23b

TABLE 3: CLASSROOM BEHAVIOURAL OBSERVATIONS.....25a

TABLE 4: MATCHING FAMILIAR FIGURES TEST DATA....27a

TABLE 5: WOODCOCK-JOHNSON PSYCHOEDUCATIONAL BATTERY DATA.....33a

TABLE 6: ANALYSES OF COVARIANCE SUMMARY TABLE...34a

FIGURE 1: PAIRED ASSOCIATE LEARNING PERFORMANCE AS A FUNCTION OF PRESENTATION TIME....26a

FIGURE 2: LEARNING AS A FUNCTION OF PRESENTATION TIME IN THE MIXED LIST CONDITION.....39a

APPENDICES

APPENDIX 1: THE CONNERS TEACHERS RATING SCALE.....56

APPENDIX II: DESCRIPTION OF THE STONY BROOK CLASSROOM OBSERVATION CODE.....57

SELECTIVE AND SUSTAINED ATTENTION IN ATTENTION DISORDERED, LEARNING DISABLED AND AVERAGE LEARNERS

I. INTRODUCTION

The attention deficit disorder (ADD) refers to a class of symptoms which impede learning in children of school age. The symptoms include: implusivity, short attention span and overactivity. In addition, many ADD children experience significant social conduct problems. Recent estimates (Ross and Ross, 1976; Trites, 1979) suggest that between 5 and 10 % of the school age population shows signs of this disorder. It occurs most commonly in boys, and it has been reported to be the most common cause of referral to child guidance clinics (Patterson, Jones, Whittier, and Wright, 1965). Safer (1971) suggested that 40 % of such referrals are for attention disorders. Intake information obtained at the Learning Centre (Conte, Samuels and Zirk, 1984) indicated that two-thirds of the referrals to this agency showed signs of attention disorder according to both parent and teacher checklist ratings (although this was not necessarily the cause of referral for these children).

In early studies of attention disordered children (Laufer and Denhof, 1958) the overactivity which is a characteristic feature of this disorder was the focus of attention. Thus, the term hyperactivity or hyperkinesis was used as the descriptive label. However, the current view as reflected in the Diagnostic and Statistical Manual of the American Psychiatric Association (DSM III, 1980) is that an attention deficit is the primary feature and that overactivity is an associated but not essential feature. Thus, there are two diagnostic categories in the DSM III: Attention Deficit Disorder with hyperactivity (ADDH)

and without hyperactivity (ADD).

Even with the definition of ADD offered in the DSM III, there is still a wide range of behaviour which is considered symptomatic of an attention disorder. For example, some studies focus primarily on the excessive activity which is found in some ADD children (Trites and Laprade, 1983). Other studies are concerned with the cognitive factors underlying attention disorders. For this purpose tests such as the Matching Familiar Figures Test and the continuous performance task have been used to measure impulsivity (Campbell, Douglas and Morgenstern, 1972) and inattention (Sykes, Douglas, Weiss and Minde, 1972). Social factors associated with attention disorders provide the basis of other studies. For example, peer inventories have been used to show that children diagnosed as hyperactive are among the most unpopular children in a school classroom (Pelham, Schnedler, Miller, Ronnei, Paluchowski, Budrow, Marks, Nilsson, and Bender, 1979).

This wide range of symptoms creates severe difficulties for a clinician attempting to determine if a child has an attention disorder. What symptoms can be regarded as definitive? Are there different types of attention disorder and if a child has one type is he also likely to show signs of the others? If there are different types of attention disorders, do they require different types of remedial programs?

The purpose of the first section of this paper is to discuss some of the ways that attention disorders are defined and measured. Particular emphasis has been placed on the cognitive measurement of attention disorders because of the prevailing view in the DSM III and

elsewhere (Kinsbourne, 1977; Douglas, 1980; Dykman, Ackerman, Clements and Peters, 1971) that cognitive factors provide the unifying substrate to the broad range of symptoms.

A. Literature Review of Assessment Methods

1. Behaviour Rating Scales

The most commonly used systematic method of assessing ADD involves the use of behaviour rating scales. They include the Conners (1969, 1970) rating scales, the Werry, Weiss, Peters Activity Rating Scale (Werry, 1968) and Davids Rating Scale for Hyperkinesis (Davids, 1971). The Conners scales are the most widely used and researched instruments and will be the focus of the present discussion.

Conners (1969, 1970) has developed behaviour checklists for both parents and teachers. They consist of items which describe behaviours characteristic of behaviourally disordered children. The respondent describes the child's behaviour by indicating the frequency of occurance on a scale of 0-3. Factor analytic studies of the most recent revisions of the Conners' scales (Goyett, Conners and Ulrich, 1978) have indicated five factors for the 48 item parent scale (conduct problem, learning problem, psychosomatic, impulsive-hyperactive, anxiety), and three factors for the 28 item teacher questionnaire (conduct problem, hyperactivity and inattentive-passive). It has been shown that checklist ratings can discriminate normal from clinically diagnosed hyperactive children (Conners, 1969, 1970; Werry, Sprague and Cohen, 1975), and that they are sensitive to stimulant drug effects (Conners,

1972; Sprague and Sleator, 1973).

Much of the research on the Conners scales has been concerned with their ability to identify hyperactive children. In this sense it is not consistent with the change in emphasis (as reflected in the DSM III classification) on attention as the essential feature of this behaviour disorder. As an instrument to diagnose hyperactivity, there has been considerable dispute in the literature regarding permissible inferences to be derived from the Conners' scales. Some studies (Langhorne, Loney, Paternite and Bechtold, 1976) have failed to find a hyperactivity factor. Others have found that the conduct problem and hyperactivity scales were highly correlated (Lahey, Green and Forehand, 1980; Quay, 1980). However, Trites (1979a, 1979b) and Trites and Laprade (1983) did extract a hyperactivity factor which accounted for 36 % of the variance and which appeared to be independent of the conduct problem scale.

The variety of conflicting data which have been gathered on the Conners' scales, and the fact that they are primarily concerned with the measurement of the motoric components of hyperactivity, suggest that it should be used with considerable caution. Since the Conners scores are based on the observations of parents and teachers, they are probably most sensitive to attention disorders which are expressed overtly. Empirical studies investigating the properties of the Conners scales have contrasted ratings given to clinically diagnosed hyperactive children and normal children, but have not included children with other types of learning problems. Conceivably,

there may be a substantial number of children with covert attentional difficulties not detectible using the Conners checklist methodology. It would be unwarranted to exclude these children from investigations of attention disorders. Instead, a variety of converging measures of attention (both behavioral and cognitive) should be used to assess the validity of the Conners scales. These studies should include a control group composed of learning disabled children who do not satisfy the Conners criteria for inattention or hyperactivity.

2. Cognitive Tests

For the most part cognitive tests are not used as diagnostic indicators of ADD. Rather, these tests have been used in experimental studies to examine the characteristics of attentional difficulties. In the analysis which follows the focus is on two types of tasks which have been used in investigations of ADD: short duration selective attention tasks, and sustained attention tasks. As used in this study, selective attention tasks have two characteristics: 1) they are tasks in which the subject must make comparisons between,or act on, perceptual attributes, and 2) the subject has control over the amount of time to process the relevant information. The sustained attention tasks are also distinguished by two features: 1) there is a learning or memory component to the task, and 2) the experimenter has control over the amount of processing time which is available.

In this analysis four tasks are reviewed. Two of them (The Matching Familiar Figures Test and the Porteus Maze Test) exemplify

tasks concerned with selective attention, and two of them are concerned with sustained attention (the vigilance task and the paired associate learning task).

One of the major difficulties in evaluating this literature is the lack of consistent criteria in defining the study sample. Many of the studies were conducted prior to the publication of the DSM III and used hyperactivity as the criterion for subject selection. Most of these studies contrasted the performance of a clinically diagnosed group of hyperactive children, and a normal control group with no history of learning or attention problems. Only a few studies attempted to use a more systematic method of subject identification such as the Conners checklists.

a. Selective Attention Tasks

The Matching Familiar Figures Test or MFFT (Kagan, Rosman, Day, Albert and Philip, 1964) was designed to be a measure of cognitive style. The reflective cognitive style is characterized by long response latencies and low error rates, whereas the impulsive style is associated with short response latencies and high error rates. In this task the child is presented with 12 problems. Each problem is presented on two pages: a single stimulus item appears on one page and 6 response alternatives are presented on the second page. The stimulus items consist of line drawings of familiar objects such as a telephone, a house, etc. The task of the examinee is to find the response alternative which is exactly identical to the stimulus item. The

incorrect alternatives differ only in the most minute details, so in order to find the correct response, the examinee must make careful comparisions. It has been shown (Campbell, Douglas and Morgenstern, 1972; Zahn, Abate, Little, Wender, 1975; Cohen, Weiss and Minde, 1972) that clinically diagnosed hyperactive children make more errors and have faster response times than normal children. This pattern of performance is regarded as an indication of an impulsive cognitive style. Of these three studies, only Zahn et al. used Conners ratings for the purpose of subject selection.

The most common method used to classify children into reflective and impulsive styles has been to divide the subjects into two groups by means of a median split of both errors and response times. Those who are above the median in errors and below the median in response time are classified as impulsive, whereas those who are below the median in errors and above the median in latency are classified as reflective. The shortcoming of this procedure is that the classification of any given subject is determined by the characteristics of the total sample tested. Thus, a subject tested with a group of children who were especially impulsive would be more likely to be classified as reflective, while one tested with an inordinately reflective group would be more likely classified as impulsive. Until a better method of classifying children into reflective and impulsive groups is devised, it will not be possible to determine the proportion of ADD children who are impulsive. However, on the basis of the available data one may conclude that hyperactive children tend to respond more

quickly and make more errors than normal children.

The Porteus Maze Test (Porteus, 1965) is also a test of relatively short duration. In this test the examinee is presented with a series of mazes which differ in level of complexity. As the examinee attempts to find a path through the maze with a pencil, the examiner notes the types of errors made, such as crossing the lines in the maze, entering blind alleys, lifting the pencil from the page. Conners, Eisenberg and Sharpe (1964) found that hyperactive children made more errors on the Porteus Maze Test than normal children. However, the interpretation given to this finding should be considered in light of other data which suggests that a large number of clinical populations show high error rates on the Porteus test (Porteus, 1965), and therefore, one cannot automatically conclude that a child has an attention disorder just on the basis of this task. Also, since there is an obvious motor component one cannot be sure if poor performance is due to attentional or motor factors.

b. Sustained Attention Tasks

Another class of tasks which have been used to assess attention disorders are of longer duration and require the examinee to stay on task continuously. In the vigilance paradigm (Rosvold, Mirsky and Sarason, 1956) strings of stimulus items (e.g., letters of the alphabet randomly ordered) are presented at regular intervals and the examinee is instructed to respond only to a subset of stimuli; e.g., "push a button when the letter x is preceded by the letter a". All

other letters and letter sequences are to be ignored. This is a test of sustained attention because the examinee must continuously maintain attention to the stimuli. Lapses of attention would result in errors of omission (failure to respond to a target stimulus) or commission (responding to an inappropriate stimulus). Sykes, Douglas, Weiss, and Minde (1972) and Rapoport, Buchsbaum, Wiengartner, Zahn, Ludlow and Mikkelsen (1980) found that hyperactive boys made more errors than a normal control group (Rapoport et al. used the Conners Parent Questionnaire ratings to identify hyperactive children; Sykes et al., selected their subjects by means of a physician's diagnosis). Sykes et al. also found that when the rate of stimulus presentation was slowed, the performance of the controls improved. However, no such benefit was obtained when stimulus rate was slowed for the hyperactives. Sykes et al. suggested that this failure to benefit from the slow rate also may have been a manifestation of short attention span in hyperactives.

Paired associate learning is a task in which the examinee is required to learn to associate a stimulus itme with a response item. It is the only task mentioned thus far that examines the ability to learn new material, and in this sense it may be more similar to the classroom situation than the other tasks. During paired associate learning (PAL), a stimulus item is presented first and the examinee is given a limited amount of time to anticipate the response item. After the response deadline has been reached, the response member of the stimulus-response pair is presented so that it may be studied by the

examinee. Stimuli are generally presented in lists of a fixed length, and are repeatedly presented until the entire list of associations has been learned.

Dalby, Kinsbourne, Swanson and Sobel (1977) have modified the paired associate procedure so that it would provide an index of attention span. In their procedure each child was given three different types of study periods (short, medium and long) in which to learn the paired associates. In the shortest study time condition each trial lasted four seconds; in the longest each trial lasted twelve seconds. It was hypothesized that a child with short attention span might be able to study a stimulus-response pair for a four second period, but not for a 12 second period. Consequently, they should learn more efficiently when short study periods were used. As predicted, they found that clinically diagnosed hyperactive children learned less at the slower rates than at the faster rates.

All the hyperactive children in this study were known to benefit from stimulant medication. After they were given medication it was found that they learned equally well under all three presentation rate conditions. Dalby et al. suggested that this was an indication that stimulant medication increased attention span. The findings reported in the Dalby et al. study have been replicated by Conte (1983).

While it makes intuitive sense that poor learning at slow rates of presentation is an indication of short attention span, the two studies mentioned above have investigated hyperactive children only. Thus, it is not known if such presentation rate effects also occur in

normal children or in learning disabled children who are not hyperactive or attention disordered. The validity of this methodology could be strengthened if it were found that presentation rate effects occur in ADD children only but not in normal children.

B. Summary

1. Evaluation of Methods of Assessing Attention Disorders

In the previous review two general methods of measuring attention disorders have been described. The checklist rating method exemplified by the Conners rating scales relies on the observations of a child by an observer such as a parent or teacher. In this method the observer is someone (a parent or teacher) who is quite familiar with the total life situation of the child. It was suggested that the checklist ratings may be most sensitive to attentional difficulties which are related to activity level.

With the cognitive methods, inferences about attentional constructs such as selective and sustained attention are made on the basis of performance on information processing tasks. These studies suggest that both types of attention problems are found in children identified as ADD/and or hyperactive by either checklist ratings or physician diagnosis. Presumably, the cognitive methods of assessment may be sensitive to covert attentional factors, which may or may not be apparent to an observer attempting to complete a Conners questionnaire.

What is critically important for the study of attention disorders

is the degree of overlap between these two methods (checklist and cognitive) of assessing attention. Increasingly, checklist ratings are being used to select subjects in investigations of the cognitive factors underlying attention disorders. This procedure makes the implicit assumption that inattention as defined by checklist ratings is identical to the inattention measured by cognitive tests. As stated in the review, the evidence supporting such an overlap has been gathered from studies contrasting the performance of two groups: children identified as ADD/hyperactive on the basis of a physician diagnosis or checklist rating, and a normal control group composed of children with no history of learning or attention problems. The limitation of this methodology is that it does not consider the possibility that the checklist ratings may identify only a subset of attention disordered children; i.e., there may be children who have measurable attention problems (as indicated by a cognitive test) but who would not be identified by a checklist rating as attention disordered.

To evaluate this possibility, the present work included a group of learning disabled children who did not satisfy the Conners criteria for attention disorder or hyperactivity. The performance of this group was compared to Conners defined ADD children, and to normal children on measures of both sustained and selective attention. The primary purpose of Experiment 1 was to examine selective and sustained attention in these three groups: ADD, normal, and learning disabled with no history of attentional difficulties.

In addition to their usefulness as measures of cognitive deficit,

the attention tasks described in the review may also be useful in determining the conditions in which children learn most efficiently. For example, the results presented by Dalby et al. suggest that ADD children learn most efficiently when material is presented at a rapid pace. If it can be verified that this result is obtained only in ADD children, it could mean that instructional materials should be presented differently to ADD children than to normal children. This could lead to the development of instructional packages which are specifically geared to the needs of ADD children. This approach to treatment (i.e., modifying the method of presenting instructional materials) may be contrasted with the approach taken in cognitive behaviour modification (Meichenbaum, 1977) in which the emphasis is placed on teaching the child to withhold impulsive responses by using self-instructional commands.

2. The Role of Visual-Spatial Ability in the Measurement of Attention Disorders

A characteristic feature of many of the tasks used to measure attention in children (The MFFT, the Porteus Maze Test, the Embedded Figures Test) is that they are heavily dependent on the processing of visual-spatial material. As such, two factors could be influencing performance: the ability to attend, and the ability to process visual material. In previous research it has not been established that these tasks can discriminate a visual-spatial deficit from an attention deficit, which they must do if they are effective measures of attention. This issue was the subject matter of Experiment 2.

II. PURPOSE

The general purpose of the experiments reported here was to examine selective and sustained attention in ADD, normal, and learning disabled (LD) children with no attention disorder. (For the remainder of this paper, the acronym LD will refer to a learning disabled group which does not satisfy the criteria for an attention disorder in terms of a clinical diagnosis or checklist rating). The purpose of Experiment 1 was to determine if attention deficits as measured on cognitive tasks occurred only in the ADD group (as defined by the Conners Teacher Rating Scale (CTRS)), but not in LD children or children with no history of learning difficulties (i.e., the normal control group). Experiment 2 was concerned with the role of visual-spatial skill as a determinant of performance on the selective and sustained attention tasks. As was noted previously, many of the tasks used to assess attention in children utilize visual-spatial stimuli, and it is possible that differences between normal and ADD children reported in previous studies may have arisen because of differences in visual-spatial skill, not because of differences in the ability to attend. In Experiment 2 an attempt was made to distinguish visual-spatial ability and attention on two attention tasks. Experiment 3 was concerned with the clinical utility of the paired associate methodology described by Dalby et al., (1977). As discussed in the review of the literature, this procedure contrasts performance across lists of paired associates in which the rate of presentation is systematically varied. This procedure can require several hours of testing time, which might

preclude its use in the clinical setting. In Experiment 3 an attempt was made to reduce the administration time by utilizing both rates of presentation in a single list.

III. EXPERIMENT 1: A COMPARISON OF SELECTIVE AND SUSTAINED ATTENTION IN ATTENTION DISORDERED, LEARNING DISORDERED AND NORMAL CHILDREN

A. Purpose

The primary purpose of Experiment 1 was to examine sustained and selective attention in three groups of children; ADD, normal control, and learning disabled (LD) with no attention disorder. The ADD group was defined in terms of the hyperkinesis index of the Conner Teacher Rating Scale (CTRS). This index was used because it contains items which pertain to three commonly used meanings of the term attention disorder: short attention span, lack of persistence, and behaviour problems. The LD group consisted of children with severe learning problems who showed no signs of attention disorder according to the Conners ratings.

B. Experimental Questions

1. Do the MFFT and presentation rate effects during paired associate learning (PAL) discriminate normal, LD and ADD children?

In previous work (Campbell et al., 1972) it has been shown that the MFFT can discriminate clinically diagnosed hyperactive children from normal children. However, it is not known if it can discriminate ADD children from a group of LD children. On the assumption that impulsivity as defined by MFFT performance occurs predominantly in ADD children, it was hypothesized that ADD children would show faster latencies and more errors than either the LD group or normal controls.

In previous work presentation rate effects during PAL have been found in hyperactive children, but it is not known if they are obtainable in normal children or LD children. It was hypothesized that presentation rate effects would occur in ADD children, but not in normal or LD children.

2. Is it possible to discriminate LD and ADD children on the basis of classroom behavioural observations?

This measure was used as an additional method of validating the CTRS data. The ADD and LD children tested in the present study were observed by research assistants trained in the use of the Stony Brook Classroom Observation Code. On the assumption that the CTRS is a legitimate measure of inattention, it was predicted that the ADD group would show significantly more inattentive behaviours as measured by the Stony Brook scale than the LD group.

C. Methodology

Subjects: The 24 subjects (8 - 12 years) who were tested were categorized into three groups (n=8 in each group). The attention deficit disordered (ADD) group (average age = 11.7 years s.d =1.2) was composed of 6 male and 2 female children of average intelligence, who were 2 or more years behind in reading, math or spelling. In addition, the children were at least 1 s.d. above the normative mean on the hyperkinesis index derived from the Conners Teachers Rating Scale (see Appendix I).

The learning disabled (LD) group (average age =11.1 years, s.d.=1.6)

consisted of 7 males and 1 female children of average intelligence who were two years below grade level in reading, spelling or math, but who had no symptoms of attention disorder. All children in this group scored below the normative mean on the Conner Hyperkinesis Index.

Eight children (5 males and 3 females) with no history of learning difficulties served as control subjects. These children (average age= 10.67 years s.d.=1.1) had no history of learning or behaviour problems and attended regular classes in the Calgary Board of Education. Children in the normal control group all scored below the normative mean on the Conners Hyperkinesis Index. All the children in the study were from middle class backgrounds and had a history of regular school attendence. At the time of testing the children in the LD and ADD group had received at least one year of either part-time remediation in a resource room or a full-time placement in a learning disability class.

Procedure

Two sets of measures were collected during this study: classroom measures and psychometric test measures.

Classroom Measures

All children were rated by their teachers on the Conners (revised) Teacher Questionnaire (Goyette, Conners and Ulrich, 1977), and all teachers completed the DSM III symptom checklist. In addition, the children in the ADD and LD groups were observed in their classrooms by observers trained in the use of the Revised Stony Brook Classroom

Observation Scale (Abikoff, Gittelman-Klein and Klein, 1981). The classroom observations were obtained by trained observers who were blind to the purpose of the study and the diagnostic status of the child. Observations were carried out over three sessions at two week intervals. Each observer was told to observe two children in each classroom; i.e., the target child, and a child who had no history of attention disorder (according to the report of the classroom teacher). The observer did not know which was the target child. Each child was observed for 16 minutes (32 minutes/classroom) in four 4 minute blocks. After observing a child for four minutes, the observer switched to the other child.

Each of the two observers who participated in this study was trained in the use of the Stony Brook Classroom Observation scale until they achieved an inter-rater reliability of at least .85 across each of the behaviours sampled with the Stony Brook scale.

The Stony Brook scale utilizes a time sampling procedure in which the child's behavior is recorded in 15 second intervals. In the modification of this scale which was used six classes of behavior were used. Three of these were untimed behaviours; i.e., each time the behaviour occurred, it was checked. These behaviours included: interference, minor motor movements and gross motor standing. Three behaviours were timed; i.e., they must be displayed continuously for at least one entire interval of 15 seconds before they are recorded. These behaviours include: off task, out of chair, and non-compliance. The categories of behaviour used in the Stony Brook Scale are explained more fully in Appendix II.

Psychometric and Cognitive Testing

Each child was tested in three one hour sessions on three different days. The maximum time interval between the first and third session was one week.

The Matching Familiar Figures Test was presented according to standardized procedures. Two practice trials were given prior to the start of the test. Performance was assessed by measuring latency to first response, and the total number of errors. Norms published by Salkind were used to transform the scores into percentiles.

The paired associate learning task was presented on an Apple II plus computer. The stimulus material presented on a NEC character display, consisted of a 5 x 5 matrix and a series of numbered boxes below the matrix. Each cell in the matrix was two centimeters square. Each learning trial was divided into two parts: stimulus presentation and response, and study time.

A stimulus presentation consisted of the presentation of an asterisk in one of the cells of the matrix for three seconds. After this period, the asterisk appeared in one of the numbered boxes below the matrix. The subject's task was to learn to associate the matrix cell in which the asterisk appeared with the numbered box. In order to receive credit for a correct response, the subject had to type in the number of the correct numbered box in the computer keyboard during the three second stimulus presentation period. Subjects were given 12 trials to learn the association between stimulus and response. If all items in the list were learned to the criterion of two successive correct responses, the

trial was terminated. If criterion was not reached, then the test was terminated after 12 stimulus presentations.

Practice Trials

Stimuli were presented in lists, and the number of stimuli in each list was adjusted to suit the ability of the individual subject. Ability level was determined by means of three practice sessions. On the initial practice session each subject was given a four item list. If the child learned all the items in the list to the criterion level of two successive correct responses for all items, the number of items was increased by two on the next practice session. If the list was not learned to criterion, then the number of items was kept the same on the next practice session. The procedure was followed for all three practice sessions. If the subject learned the list to criterion on the third practice session, the number of items used on the first experimental list was increased by two items. If the list was not learned, the number of items was not changed.

Experimental Trials

After the three practice sessions were completed, each child was given three experimental lists. The number of items used in these lists did not vary: i.e., the number indicated by the practice trials was maintained throughout all experimental tests. Three types of paired associate lists were used. In the six second list, each trial lasted for six seconds (three seconds for stimulus presentation and response

and three seconds study time during which the stimulus and response pair were both presented on the screen). In the twelve second list, each trail lasted for 12 seconds (three seconds for stimulus presentation and 8 seconds of study time). In addition to the 6 and 12 second lists, a third list was used (termed the mixed list) in which half the items were presented at a 6 second rate and half at the 12 second rate (average rate of presentation for the entire list was 9 seconds/item). The mixed list was used in order to determine if both rates of presentation could be presented in the context of a single list. The results of the mixed list are presented in Experiment 3. The paired associate tests were presented in three orders as follows:

TEST ORDER

1st	2nd	3rd
6 second	mixed	12 second
12 second	6 second	mixed
mixed	12 second	6 second

Day 1

1. Paired Associate Learning Practice I
2. Paired Associate Learning Practice II

Day 2

1. Paired Associate Learning Practice III
2. Matching Familiar Figures Test
3. Experimental Paired Associate Test I

Day 3

1. Experimental Paired Associate Test II
2. Experimental Paired Associate Test III

D. RESULTS

Age

Analysis of variance indicated that there were no age differences among the three groups of subjects ($F_{2, 21}=1.8$ $p>.1$).

Intelligence

WISC-R scores were obtained from the files of the children in the LD and ADD groups and are shown in Table 1. Analysis of WISC-R scores indicated that there was no between group difference in verbal ($t_{(15)}=.25$, $p>.4$) performance, ($t_{(15)}=.54$, $p>.1$) or full scale IQ ($t_{(15)}=.64$, $p>.1$).

Conners Rating Scale Data

Subjects were assigned to groups on the basis of the hyperkinesis index of the CTRS. For each of the groups the hyperactivity, inattention and the hyperkinesis factor scores were computed and are shown in Table 2. Inspection of Table 2 indicates that the ADD group had considerably higher scores than the other two groups across all

TABLE 1

WISC-R SCORES

	Verbal	Performance	Full Scale
ADD	97.0	94.6	95.0
LD	94.3	94.8	93.8

TABLE 2

CONNERS TEACHER RATING SCALE

	Hyperactivity Factor	Inattention Factor	Hyperkinesis Index
ADD	2.06	1.31	2.23
Normal	- .97	- .95	- .79
LD	- .79	- .07	- .68

three scores derived from the Conners. (Note that the scores in the table are given in standard scores). Statistical analysis indicated that the ADD group were given significantly higher scores on the hyperactivity factor than the LD group ($t_{21}=10.2$, $p<.001$) and the controls ($t_{21}=10.78$, $p<.001$). For the inattention factor, the ADD group had significantly higher scores than the LD group ($t_{21}=3.75$, $p<.01$) and the controls ($t_{21}=6.26$, $p<.001$). In addition, the LD group was significantly more inattentive than the controls ($t_{21}=2.51$, $p<.05$). Note, however, that even though the LD group was given significantly higher inattention scores than the controls, the mean score for the LD group was below the normative mean. In other words, according to the published norms, the LD group was no more inattentive than the average normal child. Finally, for the hyperkinesis index the ADD group was rated significantly higher than the LD group ($t_{21}=10.25$, $p<.001$) and the controls ($t_{21}=11.11$, $p<.001$).

To summarize, the ADD group was given higher ratings on all three indices derived from the Conners as compared to the normal and LD groups. The LD group was given a higher inattention rating than the normals.

Classroom Behavioural Observations

The first question considered in this report was concerned with the ability of the CTRS to discriminate ADD and LD students. The behavioural observation data was used to compare the attentive behaviours of these two groups.

The behavioural observation data (Table 3) were collected only on

the subjects in the LD and ADD groups. Each value in the table represents the mean of three 16 minute observation periods. The means for each measure were compared with a t test which indicated that the ADD group had a higher incidence of off-task behaviour than the LD group ($t(11)=3.44$, $p < .005$). None of the other comparisions was significant.

Paired Associate Learning Performance

Practice Effects

Presentation rate conditions were presented in three orders (six, twelve, mixed; twelve, mixed, six; and mixed, six, twelve). Conceivably, even though subjects were given three practice trials, performance may have improved across the three testing sessions. For example, for subjects tested in the six, twelve, mixed order, there may have been a higher level of performance on the mixed list than the other two lists, because the subjects were more familiar with the task. Such practice efficts would greatly complicate the assessment of presentation rate effects, because one could not be sure that a change in performance across lists was due to the effects of presentation rate or practice.

To examine this issue, the PAL data were grouped according to order of occurrance; i.e., all tests given first, second and third were grouped. Analysis of the means indicated that there was little change across testing sessions (percent correct on the first test =56.2 %; second test=58.6 %; third test=59.7 %). Analysis of variance indicated

TABLE 3

CLASSROOM BEHAVIOURAL OBSERVATIONS

	ADD		LD	
	Mean Number of Fifteen Second Intervals that the Behaviour Occurred			
	Mean	SD	Mean	SD
Interference	10.2	6.0	5.5	6.9
Off Task	7.4	2.3	2.6	2.6
Non-Compliance	.2	.5	.3	.8
Minor Motor Movements	5.0	4.3	3.7	2.0
Gross Motor Standing	5.7	4.3	2.9	2.9
Out of Chair	1.3	1.6	2.1	4.7

that performance did not differ across tests ($F_{2,34}=.2$, $p>.5$).

Presentation Rate Effects

The purpose of this analysis was to determine if there were systematic differences in learning across presentation rate conditions. Data for the 6 and 12 second fixed presentation rates are shown for the three groups of subjects in Figure 1. Note that the variable on the x axis is time. The learning data were presented in such a way that the total amount of presentation time was held constant across the three presentation rate conditions. For example, for the first time point at 24 second, the data for the fourth trial of the 6 second rate were used (6 seconds x 4 trails=24 second presentation time). In contrast, for the 12 second rate, the data from the second trial were used (12 seconds x 2 trials=24 second presentation time). Inspection of the figure shows that there were substantial differences across presentation rates for the ADD and LD groups but little difference for normal groups. Analysis of variance indicated that there were no between group differences in performance at the 6 second rate ($F_{2,21}=.77$, $p>.3$) and no group x time interaction ($F_{8,84}=.74$, $p>.5$). However, there was a significant difference at the 12 second rate ($F_{3,70}=7.38$, $p<.01$). Decomposition of this effect indicated that the ADD group showed a lower level of performance than the normal group ($F_{3,41}=5.5$, $p<.01$). Comparison of performance between the LD group and normals indicated a significant between group difference ($F_{1,14}=7.50$, $p<.02$) and a time x group interaction ($F_{3,41}=4.57$, $p<.01$). There was no difference

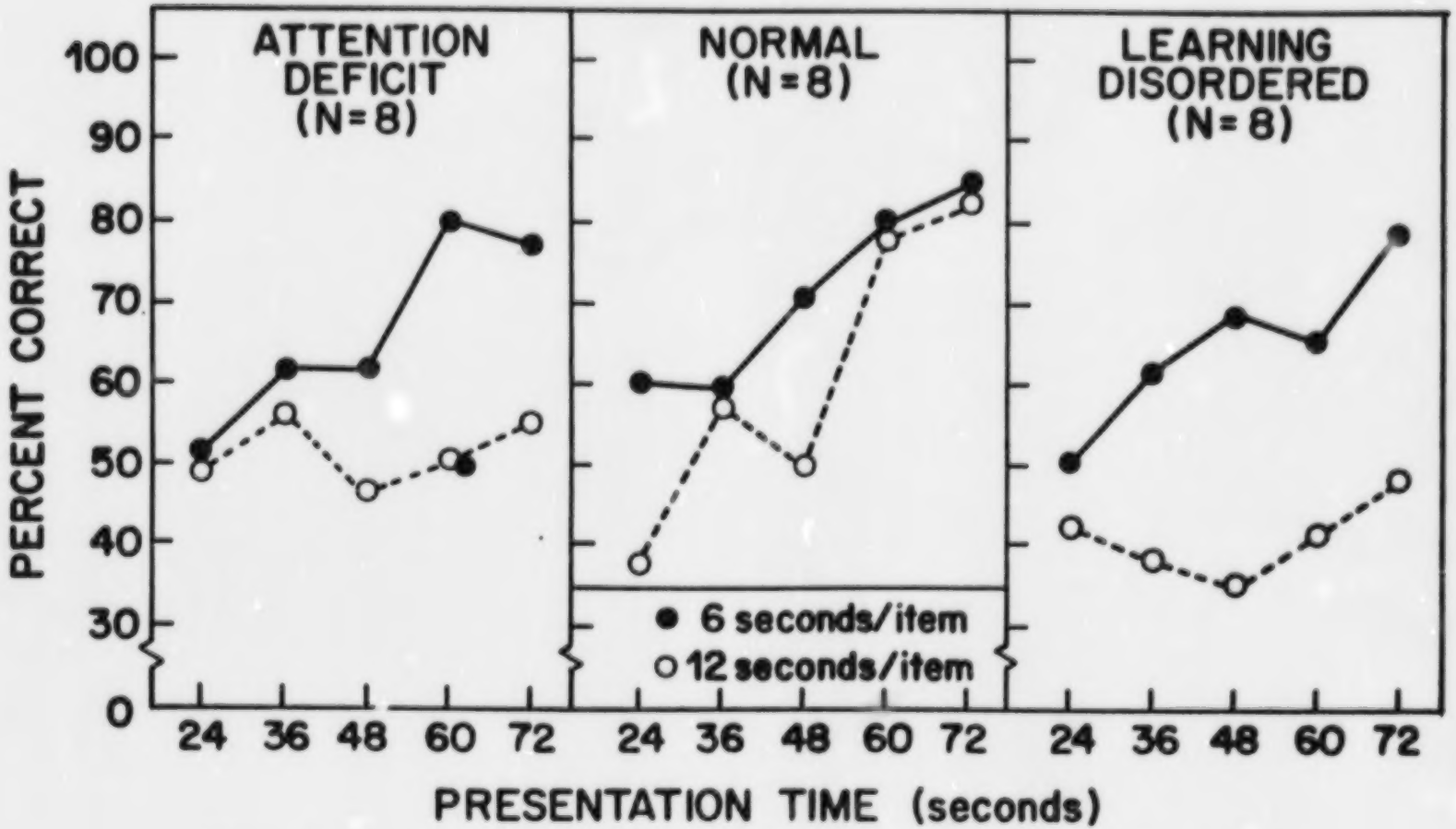

FIGURE 1: PAIRED ASSOCIATE LEARNING PERFORMANCE AS A FUNCTION OF PRESENTATION TIME

between the ADD and LD groups at either rate of presentation.

Items Used During Paired Associate Learning

As was noted previously, the number of items used during paired associate learning was determined individually for each subject during practice session. Significantly more items were used for normal subiects (mean=7.5, s.d.=1.4) than for either ADD (mean=6.5, s.d.=1.1, $t_{21}=2.23$, $p<.05$) or LD (mean=6.0, s.d.=.3, $t_{21}=3.17$, $p<.01$). There was no difference between the LD and ADD groups ($t_{21}=.90$, $p>.05$).

The Matching Familiar Figures Test

Analysis of the percentile scores from the MFFT (see Table 4) indicated that the LD group had significantly faster latencies than the ADD group ($t_{21}=2.52$, $p<.02$) and the contrcls ($t_{21}=2.24$, $p<.04$). Also, the LD group made significantly more errors than the controls ($t_{21}=2.64$, $p<.02$). Thus, in terms of the descriptive labels used to describe the results of the MFFT, the LD group was more impulsive than the ADD group or the controls. The ADD group did not differ from the controls on the impulsivitv-reflectivity dimension. However, it should be noted that the latencies of the LD group were in the average range insofar as the group mean was at the fiftieth percentile. Only the error score (seventy-fifth percentile) was substantially above the normative mean.

TABLE 4

MATCHING FAMILIAR FIGURES TEST
Percentile Scores

	ADD		Normal		LD	
	Mean	SD	Mean	SD	Mean	SD
Errors	55.2	21.4	43.7	24.7	71.6	16.1
Latency	78.5	11.7	75.4	28.1	50.1	24.3

E. Discussion

The purpose of Experiment 1 was to examine selective and sustained attention in three groups of children (ADD, LD. and normal), and to determine the degree of consistency across these measures. The review of the literature indicated that there was evidence suggesting both selective and sustained attention deficits in ADD/hyperactive children. However, the review also indicated that such studies have only compared hyperactive/ADD children and normal children. There have been no attempts to systematically examine attention deficits in children with learning difficulties, but who are not hyperactive or attention disordered.

The general hypothesis considered in this study was that cognitive indices of attention disorder would occur in CTRS defined ADD children, but not in LD or normal children. Analysis of the data indicated that of the three measures which were examined only the inattention score from the Stony Brook Classroom Observation Scale supported this hypothesis. According to the Stony Brook ratings, the ADD group showed a higher incidence of off-task behaviour than the LD group. None of the other measures derived from this scale differed between groups. No conclusions can be made regarding the normal controls because they were not included in the classroom observations.

The results of the MFFT ran counter to the proposed hypothesis. In this case the LD group made significantly more errors and had shorter response latencies than the other two groups, and there was no difference between the ADD group and the controls. Thus, according to

this measure of attention, the LD group showed a more impulsive response style than the other groups. According to the definitions established previously, the LD group had a deficit in selective attention relative to the other two groups.

Finally, the paired associate learning data ran counter to the proposed hypothesis because there was evidence of an attention deficit in both the LD and ADD groups. The ADD and LD groups showed a deficit relative to controls only at the slow rate of presentation. There was no difference between either of these groups and the controls at the faster rate. Also, the ADD and LD groups did not differ at either rate of presentation. According to the assumptions which were made previously, the PAL data would be indicative of short attention span in the LD and the ADD groups.

One interpretation of this pattern of findings is that there are different types of attention deficit in the ADD and LD groups, and that the measures used were differentially sensitive to them. According to this explanation, the CTRS and Stony Brook observational scales are sensitive to attention deficits which are given overt expression. The data indicated that this type of deficit was present in the ADD group but not in the LD group. The results of the MFFT indicated that the deficit in the LD group could be described in terms of impulsivity No such deficit was apparent in the ADD group. Finally the paired associate test indicated an attention deficit in both groups insofar as both the LD and ADD groups learned less than controls at the 12 second rate but not at the 6 second rate. One implication of this

finding is that the PAL test is the most robust measure of inattention because it was sensitive to the attention deficits in both the ADD and LD groups.

An alternative view is that the ADD and LD groups may have a common attribute which has nothing to do with attention. Intelligence may be excluded because both groups had IQ's in the normal range. Considering the fact that the MFFT and the PAL test are both heavily dependent on processing of visual information, the visual processing skills of the subjects might have been relevant to the results. For example, the LD group may have performed poorly on the MFFT because they had poorer visual processing skills than either the ADD or normal groups. Or possibly the poor PAL performance of the LD and ADD groups may have been due to deficiencies in visual processing skills in both these groups. These alternative explanations were investigated in Experiment 2.

IV. EXPERIMENT 2: THE ROLE OF VISUAL-SPATIAL ABILITY IN THE MEASUREMENT OF SUSTAINED AND SELECTIVE ATTENTION DEFICIT

A. Purpose

The purpose of Experiment 2 was to examine the role of visual-spatial skill as determinants of performance on the Paired Associate Test and Matching Familiar Figures Test.

B. Experimental Questions

On the assumption that visual-spatial skill was a major determinant of performance on the selective and sustained attention tasks, it was hypothesized that the ADD and LD groups would have significantly lower scores on the visual-spatial subtests of the Woodcock-Johnson Psychoeducational Battery. Second, if the paired associate and MFFT scores were adjusted for visual-spatial skill by using the scores on the visual-spatial test as a covariate in an analysis of covariance then the between group differences reported in Experiment 1 would be eliminated. If visual-spatial skills did not contribute to the effects, then the covariate would not alter the previously reported levels of significance.

The difficulty with this approach is that there are a number of ways of assessing visual functioning, and there is no obvious rationale to assist one in selecting an appropriate measure of visual-spatial ability. The approach taken was to use two visual-spatial tasks which differed in several ways to obtain a broadly based estimate of visual-

spatial functioning. The two measures of visual-spatial ability which were used were taken from the Woodcock-Johnson Psychoeducational Battery: the visual matching subtest and the spatial relations subtest. The visual matching subtest of this test battery is quite similar to the MFFT: it is a match-to-sample task in which subjects are given a number and must find a identical number from a set of alternatives. The major difference between this test and the MFFT is the nature of the material (the Woodcock-Johnson uses numbers whereas familiar objects are employed as stimulus material in the MFFT). In addition, the visual matching test is performed under time pressure; i.e., subjects are given three minutes to complete the test. The spatial relations subtest is also a match-to-sample task in which the examinee is given a standard figure and a series of parts of figures some of which are parts of the standard figure. The examinee must pick the parts which, in combination, form the standard figure.

C. Methodology

Subjects: The same subjects who were used in Experiment 1 were tested in Experiment 2.

Procedure

Visual-spatial skills were measured by examining performance on the Woodcock-Johnson Psychoeducational Battery, perceptual- speed cluster. This cluster consists of two tests. In the visual-matching test the examinee must find the two numbers in the row which are identical. The test begins with single digit numbers and progresses to 5 digit numbers

at the completion of the task. The number of correct matches made in three minutes is recorded. In the spatial relations subtest the examinee is presented with a row of shapes. The leftmost shape is a composite figure made up of two or more of the shapes to the right of it. The examinee must select those shapes which, when combined, make up the composite figure. The subject is allowed only three minutes to complete as many of the problems as possible.

D. Results

Three scores were obtained from the perceptual speed cluster of the Woodcock-Johnson Psychoeducational Battery: visual motor raw score, spatial relations raw score, and perceptual speed cluster score. The cluster score (expressed as an age score) is a composite score which is based on performance on both the visual matching and spatial relations subtests.

Table 5 shows the three scores obtained from the perceptual speed cluster. It can be seen that the ADD and LD groups both have significantly lower perceptual speed scores than the controls (ADD vs controls, t_{21} =2.8, $p < .01$; LD vs controls, t_{21} =2.92, $p < .01$). The LD and ADD groups scored approximatley two years below chronological age level, whereas the controls scored more than three years above their chronological age level. Analysis of the subtest scores indicated a similar pattern of results: For both subtests the LD group and the ADD group showed a significantly lower level of performance than controls.

TABLE 5

WOODCOCK-JOHNSON PSYCHOEDUCATIONAL BATTERY

Perceptual Speed Cluster Scores

	Visual-Motor Raw Score		Spatial Relations Raw Score		Perceptual Speed Age Score	
	Mean	SD	Mean	SD	Mean	SD
ADD	16.5	1.43	37.1	4.6	9.6	1.2
Normal	23.6	2.21	43.3	4.8	14.0	5.0
LD	16.3	1.31	37.0	4.1	9.5	1.0

Given that the analysis of the perceptual speed cluster indicated that the ADD and LD were lower functioning than controls, it may be that this deficit also accounted for the between group differences which were obtained on the MFFT and PAL. To investigate this possibilty, the MFFT and PAL data were reanalyzed using each of the perceptual speed scores (visual motor, spatial relations, perceptual speed cluster score) as a covariate. The analysis of covariance was used to adjust the scores on the MFFT and PAL for the linear effects of visual-spatial ability as measured by the Woodcock-Johnson perceptual-speed cluster. If any of the between group differences on the MFFT or PAL were due to between group differences in visual-spatial skill, then the introduction of the covariate should eliminate those differences.

The analysis of variance summary without the covariate is shown to the left of Table 6, and with the covariate to the right. First, for MFFT errors it was found that the introduction of the covariate eliminated the between group differences and this occurred for all three perceptual speed measures: visual motor, spatial relations and perceptual speed cluster score. However, in the analysis of the MFFT latency data, the introduction of the perceptual speed covariates did not substantially alter the between group differences.

For the PAL data the analysis of covariance was used to reanalyze the differences between groups at the 12 second rate of presentation, since it was found that this condition differentiated the three groups. In this case the introduction of the covariates did not significantly reduce the size of the differences between groups.

TABLE 6

ANALYSES OF COVARIANCE

SUMMARY TABLE

F Values for Matching Familiar Figures Test with and without Covariates from the Woodcock-Johnson Perceptual Speed Cluster

	Latency	Errors
Without Covariate	3.82	3.53
Spatial Relations Covariate	3.04	2.32
Visual-Matching Covariate	3.10	1.91
Perceptual-Speed Covariate	3.27	2.19

E. Discussion

The MFFT and the PAL task used in the present work required processing of visual-spatial information. In the MFFT the examinee must attend to visual detail, whereas in the PAL task it was necessary to learn to associate positions in space. In both tasks it is quite conceivable that subjects' visual-spatial skills may have contributed to the between group differences in performance which were observed. Analysis of the data obtained from the perceptual speed cluster of the Woodcock-Johnson Psychoeducational Battery indicated that there were significant differences in visual-spatial ability across the three groups of subjects. The normal subjects were approximately three years above chronological age(C.A.) on the perceptual speed cluster score, whereas the LD and ADD groups were both two years below C.A. When the effects of visual perceptual skill (as measured by the Woodcock-Johnson) were removed from the MFFT and PAL scores by means of an analysis of covariance, it was found that between group differences in MFFT errors were eliminated, but those for MFFT latencies and PAL performance were not.

One interpretation of this finding is that the MFFT scores may be substantially influenced by the examinees' visual-spatial skills; i.e., those with poor visual-spatial skills tend to make many errors; those with good visual-spatial skills make few errors. If this were so, it would cause one to seriously question the ability of the MFFT to provide an index of impulsivity. The second implication of the present findings is that the paired associate test is less affected by visual-spatial ability, and as such, may be a more accurate measure of

inattention.

An alternative explanation which cannot be ruled out is that visual-spatial ability may have been more closely related to MFFT scores than PAL because the tasks employed in the Woodcock-Johnson Battery are more similar to the MFFT than they are to PAL. Both the visual matching and spatial relations tests are match-to-sample tasks as is the MFFT. Also, the MFFT and Woodcock-Johnson tasks require attention to visual detail, and neither of them has a memory component. The only similarity between PAL and Woodcock-Johnson tasks is that they use visual materials. The PAL task required subjects to remember spatial positions, but there were no figures or numbers used as stimuli.

One other possibility is that the subtests included in the Woodcock-Johnson do not provide "pure" measures of visual-spatial ability, but that the scores are subject to contamination by attentional factor. Given the similarity between the MFFT and Woodcock-Johnson perceptual speed subtests, if MFFT performance is influenced by attentional factors, then it would be reasonable to propose that Woodcock-Johnson scores are similarly influenced. This conclusion is also supported by the comparisons between WISC-R performance IQ,s and Woodcock-Johnson perceptual speed scores of subjects in the LD and ADD groups. The mean WISC-R scores of both groups were in the normal range. If they were low functioning in visual-spatial ability (as suggested by the Woodcock-Johnson), then one would have predicted lower WISC-R performance scores.

To summarize, the results of Experiment 2 point to difficulties

in obtaining reliable indices of attention and visual spatial ability in children with attention disorders. One must have tests available which can measure attention which are not affected by visual-spatial ability and conversely, one must have tests of visual-spatial ability which are not contaminated by the child's ability to attend. The present results suggest that the Woodcock-Johnson perceptual speed cluster is probably not a reliable measure of visual-spatial skills because this score is likely to be contaminated by attentional factors. The contamination of PAL or MFFT scores by level of visual-spatial ability is less clear from the present data. However, since most of the tests used as measures of attention such as the MFFT, Porteus Maze test, and Embedded Figures Test require subjects to process visual-spatial information, it is possible that the results of the tests may be contaminated by visual-spatial skills. Clearly, what is needed are investigations of attention disordered children which compare measures of attention in different modalities. Given the large number of tests which are visual, emphasis should be placed on developing tests which require the processing of auditory information.

V. EXPERIMENT 3: PRESENTATION RATE EFFECTS DURING A MIXED LIST CONDITION

A. Purpose

One of the difficulties inherent in using the paired associate methodology as described in this study is that it is rather time consuming to implement. Pilot testing has indicated that at least three practice trials are needed in order to eliminate practice effects. Also, at least two experimental trials are needed (one fast rate and one slow rate of presentation). Each session can take up to 1/2 hour; thus, the total testing time could take 2 1/2 hours. The purpose of Experiment 3 was to reduce the administration time.

The approach taken in Experiment 3 was to present both rates of presentation within a single list: 1/2 the items at a slow rate and 1/2 at a fast rate. For example, if a single list presentation could be used it might be possible to reduce or even eliminate the practice trials. As such, a practitioner could obtain an estimate of a child's attentional skills after a 15 or 20 minute session.

B. Experimental Question

The rationale for using the single list presentation was based on the assumption that ADD children performed poorly at slow rates of presentation because the length of the individual trials exceeds their short attention span. If this is an accurate description of the process underlying the presentation rate effect, then it should be possible to obtain it by presenting half the items in a single list at a fast rate and half at a slow rate. Therefore, it was hypothesized

that ADD children and LD children would learn the slow rate items less efficiently than the fast rate items.

C. Methodology

Subjects: The same subjects were used as described in Experiment 1.

Procedure

The paired associate task utilized was identical to that described in Experiment 1, except that half the items were presented at the 12 second rate and half at the 6 second rate. Thus, for subjects who received a 6 item list, 3 of the items were designated as 6 second items and 3 items were designated 12 second items. In each list the 6 second items were always presented for 6 seconds and the 12 second items for 12 seconds.

D. Results

As in the analysis of presentation rate effects within the fixed lists, the amount of study time on the two rates was equated for the purpose of statistical analysis. Thus, comparisons of the amount learned were made at 24,36,48,60 and 72 seconds of study time. These data are shown in Figure 2 which indicates that the normal group showed a somewhat lower level of performance on the 12 second items than the 6 second items. Also, the level of performance across both rates of presentation was somewhat lower for the LD group than for the other two groups. Analysis of variance indicated a significant effect of time ($F_{4,84}=6.08$, $p < .001$); i.e., subjects learned more as a function of time on task. However, there were no significant main effects or interactions involving rate of presentation or group. Thus, the differences

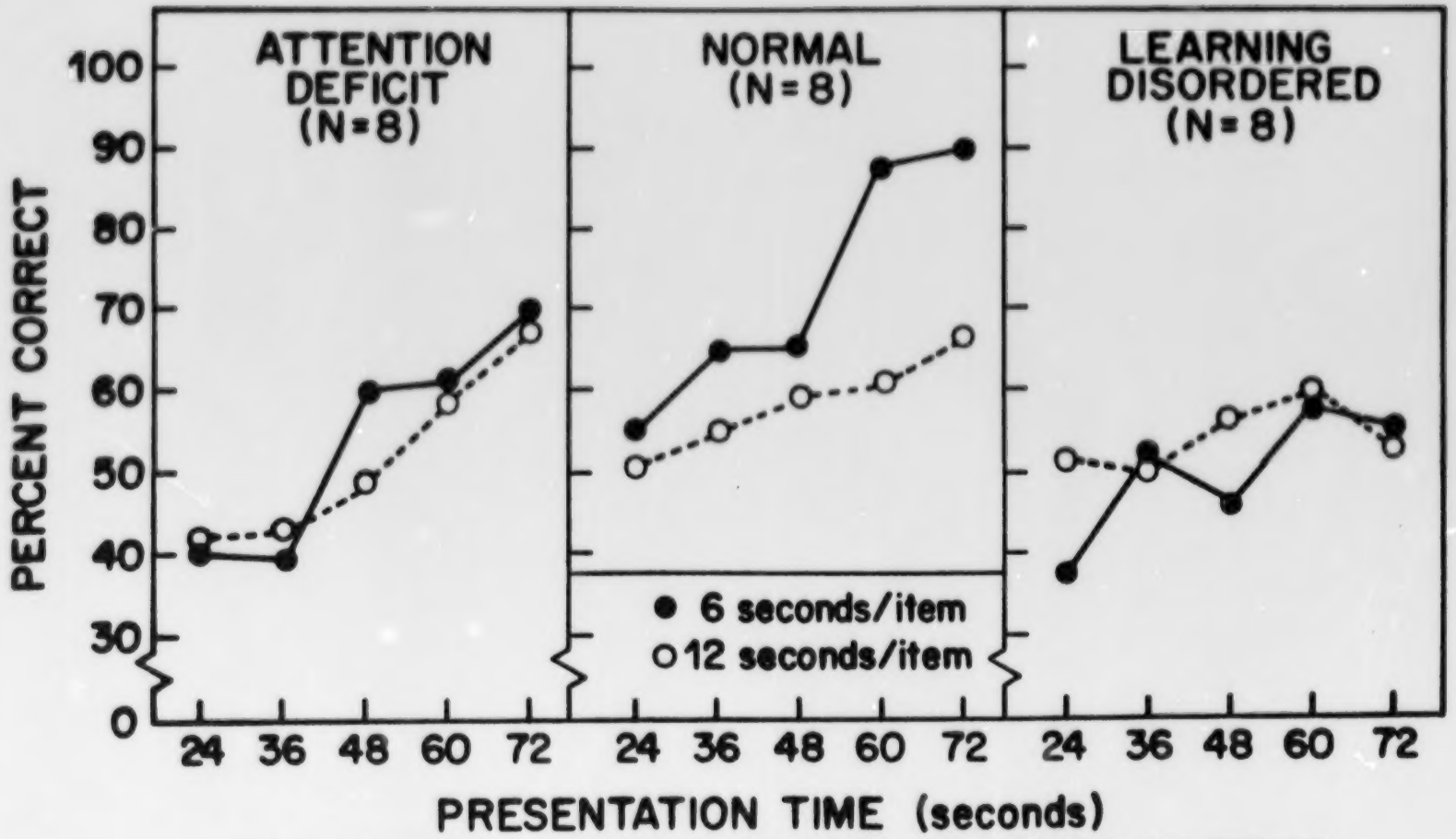

FIGURE 2: LEARNING AS A FUNCTION OF PRESENTATION TIME IN THE MIXED LIST CONDITION

apparent in the figure did not emerge statistically significant.

E. Discussion

The results of the mixed list condition contrasted sharply with those obtained in comparisions of the 6 and 12 second fixed presentation rate lists. Within the mixed list no between group differences were found involving rate of presentation. In contrast, when fixed presentation rate lists were used in Experiment 1, the LD and ADD groups learned significantly less than the normal group at the 12 second rate, but not at the 6 second rate.

There are two major implications of the data presented. First, it may not be possible to shorten the procedures for administering the paired associate methodology because the results do not replicate those obtained when fixed lists are used. The second implication concerns the underlying cause of the presentation rate effect. It had been suggested previously, that individuals with short attention span learn poorly at slow rates of presentation because the length of the trials exceeds their limited attention span. If such a process accurately described the factors at work during slow presentation rate conditions, then the results of the mixed list condition would have replicated those obtained in the fixed presentation rate comparison. Since this result did not occur, it is reasonable to reconsider the factors which lead to poor performance at slow rates. The fact that this phenomenon occurs in the fixed list, but not the mixed, suggests that the constancy of conditions might be a critical variable. In fixed list condition, every trial is twelve seconds in duration, whereas in the mixed list condition

only half the trials are presented for 12 seconds. In the fixed list condition, events such as stimulus presentation, occur infrequently over a long period of time. In the mixed list 6 second trials are interspersed between 12 second trials, and thus, would tend to break up the monotony of the situation. It may be that in order for presentation rate effects to occur, the subject must be placed in a situation in which events occur very infrequently for a long period of time. Such conditions do not occur in the mixed list condition, but they do occur in the fixed list condition. Therefore, it may be the relative lack of stimulation in the slow presentation rate condition which induces the learning deficit, not the length of the trials.

There are other explanations which cannot be ruled out on the basis of the present data. For example, in the 12 second fixed list presentation condition, the subjects have to spend relatively long periods of time rehearsing what they've learned. It may be that the subjects in the LD and ADD groups find it difficult to persist in rehearsing over a long period, or perhaps, long periods of rehearsal cause them to become excessively confused. These issues will not be resolved without further experimentation.

VI. GENERAL DISCUSSION

A. Selective and Sustained Attention Deficit in ADD and LD Children

The general purpose of the experiments presented here was to investigate selective and sustained attention in three groups of children: ADD, LD, and normal controls. Previous investigations had provided extensive documentation that both selective and sustained attention deficits were evident in the ADD population as compared to normal controls. However, non-ADD children with learning problems had not been included in such investigations. The present study began with the hypothesis that sustained and selective attention deficts would be evident in ADD, but not in LD or normal children.

Only the behavioural observation data from the present study confirmed this hypothesis; i.e., the ADD group showed significantly more inattentive behaviours than the LD group. Most of the data, however, ran counter to the hypothesis. The paired associate learning data indicated a sustained attention deficit in both the LD and ADD groups, and the MFFT results indicated a selective attention deficit in the LD group only.

The major implication of these findings is that many attention disordered children may not be identified by Conners ratings or by behaviourial observations. It may be that the Conners can identify those children with attention disorders which are expressed overtly, but there may be other types of attention deficits which are more difficult to detect by an observer.

The other major contribution of the present work is that it provides validation data for the paired associate presentation rate methodology. In previous work (Dalby et al., 1977; Conte, 1983), it had been shown that presentation rate effects occur in ADD children, but neither study utilized normal controls. The present study showed that presentation rate effects do not occur in children with no history of attention problem or learning difficulties. The unexpected finding was that presentation rate effects were also evident in the LD group. In the absence of additional information one may only speculate about the significance of this finding. First, it is unlikely that poor performance at slow rates of presentation was due to general intelligence, since both the ADD and LD groups were of average intelligence. Since the normal subjects were not IQ tested, it is possible that they had significantly higher IQ scores than the ADD or LD groups. However, there was no indication from the teacher reports that these children were of superior intelligence. Second, poor performance at slow rates of presentation may be a characteristic which is shared by all children with learning difficulties. Rehearsal skills could be relevant here because they are more important in the slow presentation condition, and it is that condition in which LD and ADD children learned less well than normals. However, the rehearsal explanation would have predicted that the LD and ADD subjects would have showed significantly poorer performance on the slow than fast items within the mixed list, and this did not occur. Even if poor rehearsal skills was a viable explanation, the inability to attend may be at the

root of this difficulty.

A third alternative explanation is that there were different types of attention deficit in the ADD and LD group (sustained and selective, respectively) but that the presentation rate methodology is sensitive to both types of attention disorder. A model which would fit these data is a hierarchical attention model in which selective attention is at a lower level than sustained attention. Efficient selective attention would be a prerequisite for sustained attention. Thus, the LD group which did poorly on the selective attention task also showed a deficit at the slow rate of presentaion. Further, in this type of model, a sustained attention deficit could exist with no deficit in selective attention (as was found in the ADD group).

Obviously, further experimentation is needed to verify this model. A useful first step would be to examine learning disabled children on a variety of different types of sustained and selective attention tasks using both auditory and visual modalities. The model which has been proposed here suggests that children with selective attention deficits would also have sustained attention deficits. Some children with sustained attention deficit would show no selective attention deficit.

B. The Role of Visual-Spatial Ability in the Measurement of Attention Disorders

Many of the cognitive tests used to assess attention disorders require subjects to process visual-spatial information (such as the MFFT, Porteus Maze tests, Embedded Figures Test). In addition, the

PAL task used in the present work required subjects to learn associations between spatial positions. Undoubtedly, subjects differ in the facility with which they can process visual-spatial information. If a subject has little aptitude for such tasks, does this mean that he is more likely to show signs of attention disorder as measured by the visual-spatial task. For example, a subject could make a large number of errors on the MFFT either because he is very impulsive and does not spend enough time deliberating over the response alternatives or because he has a great deal of difficulty in performing visual analysis.

To examine this issue, subjects in the present study were given the perceptual speed cluster of the Woodcock-Johnson Psychoeducational Battery. Both the LD and ADD groups scored 2 years below age level on this task, suggesting that the attention deficit in this group may have been at least partially due to poor visual information processing skills. However, it is also possible that the results obtained were due to the similarity between the MFFT and the tasks included in the Woodcock-Johnson Psychoeducational Battery. As such, the results may mean that the Woodcock-Johnson scores are affected by attentional factors. This conclusion is supported by the fact that the WISC-R performance scores of the ADD and LD groups were in the normal range.

The issue of the role of visual processing skills in the assessment of attention disorder still requires clarification. Resolution of this issue will require a visual-spatial task which is not sensitive to attention deficit.

On the basis of the present findings two general conclusions are warranted:

1. Woodcock-Johnson perceptual-speed cluster scores are probably not reliable indicators of visual-spatial processing because they are affected by subjects ability to attend and are not strictly measures of visual-spatial skill.

2. No study has been able to provide an independent assessment of the degree to which a performance on an attention task is a function of visual-spatial skill and inability to attend. Additional research is needed to develop a visual-spatial task which is not influenced by attentional factors, or one in which the attentional and visual-spatial components can be isolated.

C. Mechanism of the Presentation Rate Effect

Dalby et al. (1977) had suggested that ADD children could not learn when slow rates of presentation were used because the length of the trials exceeded their short attention span. The mixed list condition (half the items in the list were presented at a 6 second rate, and half at the 12 second rate) utilized in Experiment 3 was relevant to this issue, because in the explanation offered by Dalby et al., the presentation rate effect should have been just as strong under these testing conditions. However, the results indicated no difference across rates within the mixed list. This suggest that the presentation rate effect occurs only when all items in the list are

presented at a slow rate. It may be that the constant low event rate has a debilitating effect on the performance of attention disordered children, and that to maintain an effecient level of performance, attention disordered children need a relatively high level of stimulation.

D. Remedial Implications of the Data

The data presented in this study could have important implications for the design of instructional packages for attention disordered children. Although this is somewhat speculative at this point, the present studies suggest that attention disordered children learn more efficiently when there is regular change in the stimulus environment. They do not appear to learn well when they have to deliberate for long periods. However, as indicated in the results of the mixed list condition, ADD children can effectively use long study periods as long as they are interspersed with short study periods. In normal children variations in presentation rate had little impact on performance.

In terms of instructional design, it may be that learning can be substantially improved in attention disordered children by manipulating the rate of presentation. To achieve this, it may be necessary to develop new ways of structuring problems to avoid excessively long periods of deliberation. Computers could play an important role in creating such instructional packages given the great deal of control of stimulus material which they permit. More research is needed to identify the critical variables which affect learning in attention

disordered children.

An obvious alternative approach to treatment is to teach strategies to ADD children (such as those utilized in Cognitive Behaviour Modification) which will enable them to utilize long study periods more effectively. Comparison of these two forms of remediation (varying the mode of presentation vs strategies) could become the subject matter of a future investigation. It may be that a program could be developed which would combine these two approaches.

The second remedial implication concerns the Conners Teacher Rating Scale Data. The Conners scales are rapidly becoming standard instruments in the assessment of attention disorders. The data presented in the present work suggest that it should be used with considerable caution. Two of the cognitive measures of attention which were used indicated an attention deficit in the LD group which was undetected by the Conners. In discussing this result it was suggested that the Conners may be sensitive only to those attention deficits which are given overt expression. This could be of great importance clinically, because the use of the Conners could lead to misdiagnosis, and perhaps an inappropriate treatment course.

D. CONCLUSIONS AND RECOMMENDATIONS

Conclusion 1. There are attention disordered children who may not be identified by the Conners Teacher Rating Scale or by classroom behavioural observations.

Recommendation 1. A study should be carried out investigating which of the currently available rating scales are most effective at

identifying attention disordered children. This study should consider which of these scales can discriminate between the two types of attention deficit pinpointed in the presented study: selective attention deficits and sustained attention deficits.

Conclusion 2. The data collected in the present study suggest there may be two types of attention disorder: a selective attention disorder and a sustained attention disorder. In the study sample, selective attention deficit tended to co-occur with a sustained attention deficit. Sustained attention deficit could exist without any selective attention deficit.

Recommendation 2. Additional studies using different selective and sustained attention tasks should be carried out in order to determine if this model of attention deficits holds up. This should be followed up by investigations to determine if different types of treatments are required for each of the deficits.

Conclusion 3. The Woodcock-Johnson Psychoeducational Battery perceptual speed cluster is probably not a reliable measure of visual-spatial skills. The data from the present work suggest that performance on this test is strongly affected by attentional capabilities of the subjects.

Recommendation 3. Additional studies are needed to determine the extent to which sensory specific information processing deficits contribute to performance on commonly used attention tasks. Since most

attention tasks utilize visual-spatial materials, it is important to develop tasks which require the use of auditory skills. Comparison of attention across visual and auditory modalities may give a clearer picture of attentional capabilities.

Conclusion 4. Since a learning deficit at slow rates of presentation during paired associate learning occurs in ADD, but not in normal children, it suggests that this methodology may have promise as a measure of attention. Its promise was also underscored by the fact that it was sensitive to attention deficits in both the ADD and LD groups.

Recommendation 4. Additional attempts should be made to reduce the administration time for the paired associate methodology so that it could be more easily implemented in the clinical setting. It should be compared with other tests of sustained attention such as the continuous performance task and the Children's Checking Test.

Conclusion 5. The data from the present study suggest that poor performance at slow rates of presentation is not brought about because the length of the slow trials exceeds the attention span of the subjects. Instead, the deficit may be a response to a situation in which the level of stimulation is low.

Recommendation 5. The results of the present study could have implications for the development of instructional programs for learning disabled children. The pacing of instructional materials may have to be modified to suit the needs of attention disordered children. This

could be particularly important in the design of software for computer assisted instruction.

Recommendation 6. Treatment studies need to be carried out in order to determine if treatments aimed at remediating attention deficits can abolish the deficit at slow rates of presentation.

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APPENDIX I

TEACHER'S QUESTIONNAIRE

Name of Child _____ Grade _____

Date of Evaluation _____

Please answer all questions. Beside each item, indicate the degree of the problem by a check mark (✓)

	0	1	2	3
1. Restless in the "squirmy" sense.				
2. Makes inappropriate noises when he shouldn't.				
3. Demands must be met immediately.				
4. Acts "smart" (impudent or sassy).				
5. Temper outbursts and unpredictable behavior.				
6. Overly sensitive to criticism.				
7. Distractibility or attention span a problem.				
8. Disturbs other children.				
9. Daydreams.				
10. Pouts and sulks.				
11. Mood changes quickly and drastically.				
12. Quarrelsome.				
13. Submissive attitude toward authority.				
14. Restless, always "up and on the go".				
15. Excitable, impulsive.				
16. Excessive demands for teacher's attention.				
17. Appears to be unaccepted by group.				
18. Appears to be easily led by other children.				
19. No sense of fair play.				
20. Appears to lack leadership.				
21. Fails to finish things that he starts.				
22. Childish and immature.				
23. Denies mistakes or blames others.				
24. Does not get along well with other children.				
25. Uncooperative with classmates.				
26. Easily frustrated in efforts.				
27. Uncooperative with teacher.				
28. Difficulty in learning.				

0 - not at all)
1 - just a little) Response code
2 - pretty much)
3 - very much)

APPENDIX II

DESCRIPTION OF THE STONY BROOK CLASSROOM OBSERVATION CODE

There are two general categories of behaviour in this code. Timed behaviours are those which must persist for an entire 15 second interval before they are recorded. Untimed behaviours are recorded each time they occur regardless of the duration of the behaviour. The behaviour may be only checked once in each 15 second interval.

1. INTERFERENCE: This category is intended to detect any verbal or physical behaviours or noises which are disturbing to others; the purpose here is to detect a discrete and disticnt behaviour (such as calling out or clowning) which does not necessarily persist. This category is coded as an untimed behaviour.

2. OFF-TASK: This category is intended to monitor behaviour where the child, after initiating the approporate task relevant behaviour, attends to stimuli other than the assigned work. This category is coded as a timed behaviour.

3. NON-COMPLIANCE: This category is intended to monitor behaviours which reflect a failure on the part of the child to follow teacher instructions. This category is coded as a timed behaviour.

4. MINOR MOTOR MOVEMENT: This category is intended to monitor behaviours of the child which are indicative of restlessness and fidgeting such as rocking movements or twisting and turning in a seated position. This category is coded as an untimed behaviour.

5. GROSS MOTOR STANDING: This category refers to motor activity which results in the child leaving his seat and standing on at least one leg (on the floor, chair or desk). This category is coded as an untimed behaviour.

6. OUT-OF-CHAIR BEHAVIOUR: This category is intended to monitor extended out-of-seat behaviour. It is coded as a timed behaviour.

ATTENTION IN ATYPICAL AND AVERAGE LEARNERS

Summary Report

SELECTIVE AND SUSTAINED ATTENTION IN ATTENTION DISORDERED, LEARNING DISABLED, AND AVERAGE LEARNERS (SUMMARY REPORT)

Richard Conte, Harry Zirk, and Marilyn Samuels

The Learning Centre

Calgary, Alberta

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SELECTIVE AND SUSTAINED ATTENTION IN ATTENTION DISORDERED, LEARNING DISABLED, AND AVERAGE LEARNERS

The attention deficit disorder (ADD) refers to a class of symptoms which impede learning in children of school age. The chief symptoms of the disorder include cognitive factors (such as short attention span and impulsivity), difficulties in social adjustment, (excessive aggression, and lack of compliance in school and at home), and overactivity. According to recent estimates (Ross and Ross, 1976; Trites, 1979) between 5 and 10 % of the school age population show signs of attention disorder. It has also been implicated as the most common cause of referral to child guidance clinics (Patterson, Jones, Whittier, and Wright, 1965).

Special purpose tasks have been devised to provide information on the various aspects of attention disorders, and the present study is concerned with two of these: selective attention tasks, and sustained attention tasks. As used in the present study, selective attention tasks have two primary characteristics: 1) they are tasks in which the subject must make comparisons between, or act on, perceptual attributes, and 2) the subject has control over the amount of time given to process the relevant information. The sustained attention tasks are also distinguished by two features: 1) there is a learning or memory component to the task, and 2) the experimenter has control over the amount of processing time which is available.

The selective attention task used in the present work was the Matching Familiar Figures Test (MFFT) (Kagan, 1966). In this task

subjects are presented with a standard figure and six response alternatives. All but one of the response alternatives differ from the standard stimulus in minute detail. The subject must find the response alternative which matches the standard. Both the speed and accuracy of response are measured. Previous research (Campbell, Douglas and Morgenstern, 1972) has established that attention disordered children make more errors and have shorter response latencies than normal controls. This pattern of performance has been taken as an indication of an impulsive response style. It is not known if non-attention disordered learning disabled children also show an impulsive response style. This last issue was taken up in the present study.

The sustained attention task was based on the paired associate learning methodology developed by Dalby, Kinsbourne, Swanson and Sobel (1977). Paired associate learning (PAL) is a task in which the examinee is required to learn to associate a stimulus item with a response item. During PAL, a stimulus item is presented first and the examinee is given a limited amount of time to anticipate the response member. After the response deadline has been reached, the response member of the stimulus-response pair is presented so that it may be studied. Stimuli are generally presented in lists of a fixed length, and are repeatedly presented until the entire list of associations has been learned. The paired associate methodology was used in the present work because it has been shown to be closely related to classroom learning (Stevenson, 1973).

Dalby et al. have modified the paired associate procedure so that it would provide an index of attention span. In their procedure each child

was given three different types of paired associate list. In the fast presentation condition each item in the list was presented for 4 seconds. In the medium and slow conditions, trials lasted 8 and 12 seconds, respectively. The rationale for this study was that a child with short attention span might be able to maintain concentration for 4 seconds, but would not be able to do so for 8 or 12 seconds. Thus, it was hypothesized that learning would be less efficient in the 12 and 8 second conditions than in the 4 second condition. The results verified this hypothesis.

While it makes intuitive sense that poor learning at slow rates of presentation is an indication of short attention span, this paired associate methodology has been used only with attention disordered children. It is not known if such effects occur in normal children or in learning disabled children who are neither hyperactive nor attention disordered. This question was explored in the present work.

II. PURPOSE

The general purpose of the experiments reported here was to examine selective and sustained attention in ADD, normal, and learning disabled (LD) children with no attention disorder. The purpose of Experiment 1 was to determine if attention deficits as measured by sustained (paired associate learning) and selective attention (MFFT) tasks occurred only in the ADD group, but not in the normal control or LD groups. The paired associate methodology required subjects to associate spatial positions between cells in a 5 x 5 matrix presented on a computer terminal. Each subject received 3 practice lists and two experimental lists. The fast and slow rates of presentation were 6 seconds and 12 seconds/item.

Experiment 2 was concerned with the role of visual-spatial ability as a determinant of performance on the selective and sustained attention tasks. The rationale for this study stemmed from the fact that the selective and sustained attention tasks used in the present study utilized visual-spatial materials. It is possible that differences between normal, LD and ADD groups may occur because of differences in the ability to process visual-spatial materials. In Experiment 2, an attempt was made to distinguish the relative contributions of visual-spatial ability, and attention to performance on these tasks.

Experiment 3 was concerned with the clinical utility of the paired associate methodology described by Dalby et al. (1977). As described previously, this procedure contrasts performance across lists of paired associates in which rate of presentation is varied. This procedure can

require several hours of testing time, which might preclude its use in clinical settings. In Experiment 3 an attempt was made to reduce the administration time by utilizing two rates of presentation (fast and slow) in a single list.

III. THE PRESENT STUDIES

A. Experiment 1

1. Methodology

In Experiment 1 children were classified into three groups - ADD, normal control and LD - on the basis of academic history and Conners Teacher Rating Scale (CTRS) responses. The CTRS is a commonly used rating scale for selecting attention disordered subjects. The subjects were given a battery of tests including selective attention (MFFT), sustained attention (paired associate learning in which fast and slow rates of presentation were used).

2. Results and Discussion

The results can be summarized in the following three points:

1. A deficit in selective attention was obtained in the LD group, but not in the ADD or normal control groups.
2. A sustained attention deficit was evident in both the ADD and LD groups, but not the controls.
3. The ADD group showed a greater incidence of off-task behaviour than the LD group according to the classroom behavioural observations.

One interpretation of the pattern of findings obtained in Experiment 1 is that there are different types of attention deficit in ADD and LD groups, and that the measures used were differentially sensitive to them. In this view the CTRS and classroom observation

data may have detected an attention deficit which is given overt expression or which is activity based. The data suggest that the ADD group had this type of attention deficit. In contrast, the LD group had an attention deficit which was more difficult to observe. It was not detected by the observer ratings, but it was by the selective attention task. However, no selective attention deficit was evident in the ADD group. The sustained attention task was sensitive to the attention deficit in both the ADD and LD groups, and thus, one might suppose that this test is a more robust measure of attention.

An alternative view is that the ADD and LD groups may have a common attribute is not attentional in nature. Intelligence can probably be excluded because both groups had IQ's in the normal range. Considering the fact that the MFFT and PAL test are both heavily dependent on the processing of visual information, the visual processing skills of the subjects may have had some bearing on the outcome of Experiment 1. For example, the LD group may have performed poorly on the MFFT because they had poorer visual processing skills than either the ADD or normal groups. The relationship between visual processing skills and performance on the MFFT and PAL tasks was the subject matter of Experiment 2.

B. Experiment 2

1. Methodology

The hypothesis examined in Experiment 2 was that performance on the MFFT and paired associate learning test was a function of the visual-spatial abilities of the subjects. Two predictions were made on the

basis of this hypothesis. First, the ADD and LD groups should have significantly lower scores on the visual-spatial subtest (termed the perceptual speed cluster) of the Woodcock-Johnson Psychoeducational Battery. Second, if the paired associate and MFFT scores were adjusted for visual-spatial skill by using the scores on the visual-spatial test as a covariate in an analysis of covariance, then the between group differences reported in Experiment 1 would be eliminated. If visual-spatial skill did not contribute to these effects, then the between group differences reported in Experiment 1 would not be eliminated. If visual-spatial skills did not contribute to the effects, then the covariate would not alter the previously reported levels of significance.

2. Results and Discussion

Consistent with the hypothesis which was proposed, the ADD and LD groups both achieved significantly lower scores than the normal controls on both perceptual speed subtests. However, when the relationship between these measures was assessed by means of a covariance analysis, there was a significant relationship between perceptual speed scores and MFFT errors, but not for MFFT latencies or paired associate learning performance. One interpretation of these findings is that the MFFT error scores may be substantially influenced by the examinees' visual-spatial skills; i.e., those with poor visual-spatial skills tend to make many errors; those with good visual -spatial skills make few errors. If this were so, the validity of the MFFT as a measure of attention would be suspect. An additional implication would be that since the paired associate test is less affected by visual-spatial ability, it may be a "purer" measure of inattention.

An alternative explanation which cannot be ruled out is that visual-spatial ability may have been more closely related to MFFT scores than PAL because the tasks employed in the Woodcock-Johnson Battery are more similar to the MFFT than they are to PAL. Both the visual-matching and spatial relations tests are match-to-sample tasks as is the MFFT. Also, the MFFT and Woodcock-Johnson tasks require attention to visual detail, and neither of them have a memory component.

Although it is not possible to make definitive conclusions regarding the relative contributions of visual-spatial ability and attention to performance on the tasks employed, it is very likely that the modality of presentation can have substantial impact on measures of attention. Since most attention measures in current use utilize visual materials, it is important that additional studies be performed investigating the effects of modality of presentation, perhaps by developing auditory measures of attention and contrasting them with the visually based measures.

C. Experiment 3

1. Methodology

One of the difficulties inherent in using the paired associate methodology as described in this study is that it is rather time consuming to implement. Pilot testing has indicated that at least three practice trials are needed in order to eliminate practice effects. Also, at least two experimental trials are needed (one fast rate and one slow rate of presentation). Each session can take up to 1/2 hour; thus,

the total texting time could take 2 1/2 hours.

The purpose of Experiment 3 was to determine if both rates of presentation could be used in the context of a single list presentation. The rationale for using this approach was based on the assumption that ADD children performed poorly at slow rates of presentation because the length of the individual trials exceeds their short attention span. If this is an accurate description of the process underlying the presentation rate effect, then it should be possible to obtain it by presenting half the items in a single list at a fast rate and half at a slow rate.

2. Results and Discussion

The results of the mixed list condition contrasted sharply with those obtained in comparisons of the 6 and 12 second fixed presentation rate lists. Within the mixed list, no between group differences were found involving rate of presentation. In contrast, when fixed presentation rate lists were used in Experiment 1, the LD and ADD groups learned significantly less than the controls at the 12 second rate, but not the 6 second rate.

There are two major implications of the data presented. First, it may not be possible to shorten the procedures for administering the paired associate methodology because the results do not replicate those obtained when fixed lists are used. The second implication concerns the underlying cause of the presentation rate effect. It had been suggested previously that the individuals with short attention span learn poorly at slow rates of presentation because the length of the trials exceeds their limited attention span. As such, the results of the mixed list

condition should have replicated those obtained when fixed rates of presentation were used. Since this result did not occur, it is reasonable to reconsider the factors which lead to poor performance at slow rates of presentation. The fact that presentation rate effects occur in the fixed list,but not the mixed list suggests that the constancy of conditions might be a critical variable. In the fixed list condition, every trial is 12 seconds in duration, whereas in the mixed list condition only half the trials are presented for 12 seconds. In the fixed list condition, event rate is consistently low. In the mixed list, 6 second trials were interspersed irregularly between 12 second trials, breaking up the monotony of the situation. Thus, it may be the relative lack of stimulation in the slow presentation condition which induces the deficit, not the length of the trials.

IV. CONCLUSIONS AND RECOMMENDATIONS

Conclusion 1. There are attention disordered children who may not be identified by the Conners Teacher Rating Scale or by classroom behavioural observations.

Recommendation 1. A study should be carried out investigating which of the currently available rating scales are most effective at identifying attention disordered children. This study should consider which of these scales can discriminate between the two types of attention deficit pinpointed in the presented study: selective attention deficits and sustained attention deficits.

Conclusion 2. The data collected in the present study suggest there may be two types of attention disorder: a selective attention disorder and a sustained attention disorder. In the study sample, selective attention deficit tended to co-occur with a sustained attention deficit. Sustained attention deficit could exist without any selective attention deficit.

Recommendation 2. Additional studies using different selective and sustained attention tasks should be carried out in order to determine if this model of attention deficits holds up. This should be followed up by investigations to determine if different types of treatments are required for each of the deficits.

Conclusion 3. The Woodcock-Johnson Psychoeducational Battery perceptual speed cluster is probably not a reliable measure of visual-spatial skills. The data from the present work suggest that performance on this test is strongly affected by attentional capabilities of the subjects.

Recommendation 3. Additional studies are needed to determine the extent to which sensory specific information processing deficits contribute to performance on commonly used attention tasks. Since most attention tasks utilize visual-spatial material, it is important to develop tasks which require the use of auditory skills. Comparison of attention across visual and auditory modalities may give a clearer picture of attentional capabilities.

Conclusion 4. Since a learning deficit at slow rates of presentation during paired associate learning occurs in ADD, but not in normal children, it suggest that this methodlolgy may have promise as a measure of attention. Its promise was also underscored by the fact that it was sensitive to attention deficits in both the ADD and LD groups.

Recommendation 4. Additional attempts should be made to reduce the administration time for the paired associate methodology so that it could be more easily implemented in the clinical setting. It should be compared with other tests of sustained attention such as the continuous performance task and the Children's Checking Test.

Conclusion 5. The data from the present study suggest that poor performance at slow rates of presentation is not brought about because the length of the slow trials exceeds the attention span of the subjects. Instead, the deficit may be a response to a situation in which the level of stimulation is low,

Recommendation 5. The results of the present study could have implications for the development of instructional programs for learning disabled children. The pacing of instructional materials may have to be modified to suit the needs of attention disordered children. This could be particularly important in the design of software for computer assisted instruction.

Recommendation 6. Treatment studies need to be carried out in order to determine if treatments aimed at remediating attention deficits can abolish the deficit at slow rates of presentation.